Racepad
J1939 User Manual

Summary:

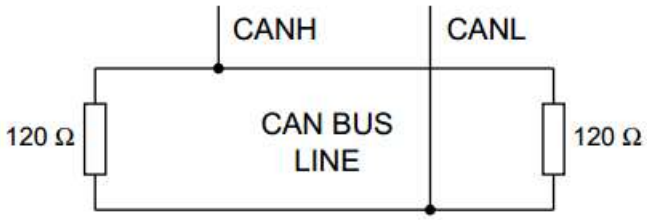
1. How to connect the wires:

Power Supply Connector		
Manufacturer	TE Connectivity / Deutsch	Amphenol
Connector p/n	DTM04-4P	ATM04-4P
Mating Connector		
Connector p/n	DTM06-4S	ATM06-4S
Wedgelock p/n	WM4S	AWM4S
Terminals	0462-201-20141	AT62-201-20141

PIN	COLOUR	FUNCTION
1	Blue	CAN L
2	White	CAN H
3	Black	Negative battery
4	Red	Vbatt. (12-24V)

Input Signal Connector		
Connector p/n: Molex 39-013-069		
PIN	COLOUR	FUNCTION
1	Red	Power +5V
2	Yellow	IN0
3	Blue	IN1
4	Grey	IN2
5	Green	IN3
6	Black	GND
Mating Connector		
Connector p/n: Molex 39-01-2065		
Terminals p/n: Molex 39-00-0039		

Warning: the input voltage range is from 0V to 5V. Do not connect input signals beyond these limits. Damage to the device may occur.



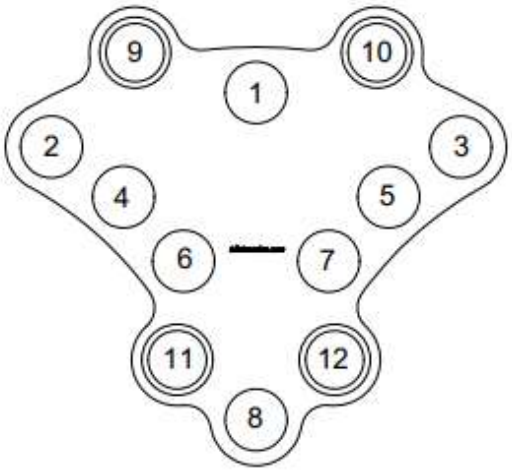
Each end of the CAN bus is terminated with 120Ω resistors in compliance with the standard to minimize signal reflections on the bus. You may need to place a 120Ω resistor between CAN-L and CAN-H.

Warning: to avoid breakage do not tighten the backshell nuts with a torque exceeding 1.8 Nm!

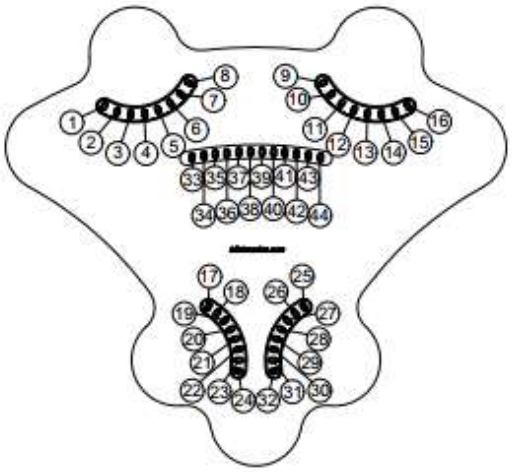
2. Reference

Racepad

KEY:



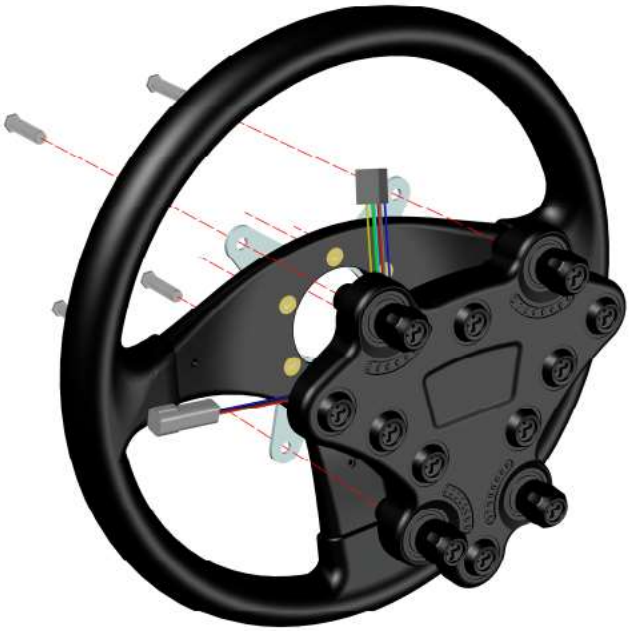
LED:



3. Mounting instructions

1: fasten the metal plate to the steering wheel by clamping the six screws.

2: assemble the Racepad to the steering wheel by fastening the M5 screws along the four holes of the metal plate and the backshell. Bend the wires to the preferred side to simplify the installation on the steering wheel.



3: plug the connectors to complete the installation.

4. Message header description

The 29-bit CAN identifier used in J1939 is structured in the following way.

Priority	Reserved	Data Page	PDU Format	PDU Specific	Source Address
3 bits	1 bit	1 bit	8 bits	8 bits	8 bits

The proprietary format used by PKP keypads is defined as follows:
Priority = **6**.
Reserved = **0**.
Data page = **0**.
PDU Format = EFh (the message is addressable).
PDU Specific = Destination Address.
Parameter Group Number:
61184 (EF00h) [PROPRIETARY A] used for configuration messages and LED command;
59904 (EA00h) used for request type messages.

An example of CAN identifier of messages sent to the keypad is 18EF2100h where:
21h is the destination address (keypad)
00h is the source address.

An example of CAN identifier of messages sent by the keypad is 18EFFF21h where:
FFh refers to broadcast messages (no specific destination address)
21h is the source address (keypad).

5. General Data Format

The proprietary protocol has defined a general format for the data fields in the PGN 61184. The format consists of:
1 header field (2 bytes)
1 command byte
5 bytes (the remaining field) are defined specifically for each command.

The data length is 8 bytes, unused bits and bytes are set to all 1's (0xFF).

Byte 0	04h
Byte 1	1Bh
Byte 2	Command
Byte 3-7	Data required for each specific command

6. Default Settings

Setting	Default state or level	How to change
CAN bus baud rate	250 kbit/s	Command 6Fh
Source address	21h	Command 70h
Keypad identifier	21h	Command 70h
Destination address	FFh	Command 6Eh
Heartbeat	Disabled	Command 75h
Periodic key-state message transmission	Disabled	Command 71h
Key-state message period	100ms	Command 77h
Event state transmission	Enabled	Command 72h
Address claim at boot	Disabled	Command 74h
Default Key-LED indicators brightness level	3Fh (100%)	Command 7Ch
Default Key-LED backlight brightness level	00h (OFF)	Command 7Bh
Default Key-LED backlight color	Amber	Command 7Dh
Default Central and encoder LED indicators brightness level	FFh (100%)	Command 69h
Default Ring LED indicators brightness level	FFh (100%)	Command 78h
Default Ring backlight brightness level	00h (OFF)	Command 79h
Default Logo backlight brightness level	7Fh (50%)	Command 7Eh
Default backlight state	Enabled	Command 03h
Startup LED show	Complete LED Sequence	Command 34h
LED acknowledgment	Disabled	Command 73h
Analog input message period	80ms	Command 6Ah
Encoder state message transmission	Enabled	Command 0Bh
Startup encoder 1 tick counter value	0000h	Command 61h
Startup encoder 2 tick counter value		Command 62h
Startup encoder 3 tick counter value		Command 63h
Startup encoder 4 tick counter value		Command 64h
TOP position encoder 1	08h	Command 6Bh
TOP position encoder 2		Command 6Ch
TOP position encoder 3		Command 6Dh
TOP position encoder 4		Command 60h

7. Key Contact state (01h)

This message is sent by the keypad to indicate the state of the keys. The destination address is set to FFh: broadcast message. See chapter 2 for Key number reference.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	01h	Key Contact state
Byte 3	XXh	XX: Key number
Byte 4	YYh	Contact State 00: Key released 01: Key pressed
Byte 5	ZZh	Keypad Identifier (default 21h)
Byte 6,7	FFh	Not used

Examples:

Direction	Identifier	Format	Message	Data
From Keypad	18EFFF21h	Ext	04 1B 01 01 01 21 FF FF	Key 1 ON
From Keypad	18EFFF21h	Ext	04 1B 01 01 00 21 FF FF	Key 1 OFF
From Keypad	18EFFF21h	Ext	04 1B 01 02 01 21 FF FF	Key 2 ON
From Keypad	18EFFF21h	Ext	04 1B 01 02 00 21 FF FF	Key 2 OFF
From Keypad	18EFFF21h	Ext	04 1B 01 03 01 21 FF FF	Key 3 ON
From Keypad	18EFFF21h	Ext	04 1B 01 03 00 21 FF FF	Key 3 OFF
From Keypad	18EFFF21h	Ext	04 1B 01 04 01 21 FF FF	Key 4 ON
From Keypad	18EFFF21h	Ext	04 1B 01 04 00 21 FF FF	Key 4 OFF
From Keypad	18EFFF21h	Ext	04 1B 01 05 01 21 FF FF	Key 5 ON
From Keypad	18EFFF21h	Ext	04 1B 01 05 00 21 FF FF	Key 5 OFF
From Keypad	18EFFF21h	Ext	04 1B 01 06 01 21 FF FF	Key 6 ON
From Keypad	18EFFF21h	Ext	04 1B 01 06 00 21 FF FF	Key 6 OFF
From Keypad	18EFFF21h	Ext	04 1B 01 07 01 21 FF FF	Key 7 ON
From Keypad	18EFFF21h	Ext	04 1B 01 07 00 21 FF FF	Key 7 OFF
From Keypad	18EFFF21h	Ext	04 1B 01 08 01 21 FF FF	Key 8 ON
From Keypad	18EFFF21h	Ext	04 1B 01 08 00 21 FF FF	Key 8 OFF
From Keypad	18EFFF21h	Ext	04 1B 01 09 01 21 FF FF	Key 9 ON
From Keypad	18EFFF21h	Ext	04 1B 01 09 00 21 FF FF	Key 9 OFF
From Keypad	18EFFF21h	Ext	04 1B 01 0A 01 21 FF FF	Key 10 ON
From Keypad	18EFFF21h	Ext	04 1B 01 0A 00 21 FF FF	Key 10 OFF
From Keypad	18EFFF21h	Ext	04 1B 01 0B 01 21 FF FF	Key 11 ON
From Keypad	18EFFF21h	Ext	04 1B 01 0B 00 21 FF FF	Key 11 OFF
From Keypad	18EFFF21h	Ext	04 1B 01 0C 01 21 FF FF	Key 12 ON
From Keypad	18EFFF21h	Ext	04 1B 01 0C 00 21 FF FF	Key 12 OFF

If the Event state transmission is enabled, the Key Contact state message is sent when a key is switched.

If the periodic key-state transmission is enabled (see Command 71h for further details), at each given time interval a Key Contact state message is transmitted for each button of the keypad.

8. Encoder 1 state message (02h)

This message is sent by the keypad to indicate the state of the encoder 1. The destination address is set to FFh: broadcast message.

Note: the encoder 1 is identified with the key number 9. See chapter 2 for further details.

The state of the encoder 1 is represented by 3 counter fields:

- The Direction counter (Byte 3) transmits the number of ticks and the direction of the encoder rotation since the last message sent. The MSB of the counter defines the direction.
- The Tick counter (Byte 4 and 5) is a two bytes counter incremented each clockwise tick and decremented each counterclockwise tick.
- The TOP position (Byte 6): when is different from 00h, it is the maximum value the encoder tick counter will count up to. In this case, with each clockwise tick the counter increases until the TOP position is reached; once reached this value, each further tick in this direction does not increase the counter. On the contrary, with each counterclockwise tick the counter decreases from the current value to zero; once reached zero, each further tick in this direction does not change the counter value.
  NOTE: the default TOP position can be set by using the configuration command *Set TOP position encoder 1 (6Bh)*. In case it is selected the value 00h the maximum encoder tick counter value is 65535.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	02h	Encoder 1 state message
Byte 3	Encoder Direction counter X Y Y Y – Y Y Y Y b	X = 0 clockwise, X = 1 counterclockwise. YYYYYYY = number of Ticks. 1 Turn (360° rotation) = 16 Ticks
Byte 4, 5	ZZ ZZh	Encoder Tick counter
Byte 6	00h or RRh	TOP position encoder 1
Byte 7	ZZh	Keypad Identifier (default 21h)

Examples:

Direction	Identifier	Format	Message	Data
From Keypad	18EFFF21h	Ext	04 1B 02 01 02 00 08 21	2 Ticks CW with 08h as TOP position
From Keypad	18EFFF21h	Ext	04 1B 02 81 FF FF 00 21	1 Tick CCW

9. Encoder 2 state message (03h)

This message is sent by the keypad to indicate the state of the encoder 2. The destination address is set to FFh: broadcast message.

Note: the encoder 2 is identified with the key number 10. See chapter 2 for further details.

The state of the encoder 1 is represented by 3 counter fields:

- The Direction counter (Byte 3) transmits the number of ticks and the direction of the encoder rotation since the last message sent. The MSB of the counter defines the direction.
- The Tick counter (Byte 4 and 5) is a two bytes counter incremented each clockwise tick and decremented each counterclockwise tick.
- The TOP position (Byte 6): when is different from 00h, it is the maximum value the encoder tick counter will count up to. In this case, with each clockwise tick the counter increases until the TOP position is reached; once reached this value, each further tick in this direction does not increase the counter. On the contrary, with each counterclockwise tick the counter decreases from the current value to zero; once reached zero, each further tick in this direction does not change the counter value.
  NOTE: the default TOP position can be set by using the configuration command *Set TOP position encoder 2(6Ch)*. In case it is selected the value 00h the maximum encoder tick counter value is 65535.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	03h	Encoder 2 state message
Byte 3	Encoder Direction counter X Y Y Y – Y Y Y Y b	X = 0 clockwise, X = 1 counterclockwise. YYYYYYY = number of Ticks. 1 Turn (360° rotation) = 16 Ticks
Byte 4, 5	ZZ ZZh	Encoder Tick counter
Byte 6	00h or RRh	TOP position encoder 2
Byte 7	ZZh	Keypad Identifier (default 21h)

Examples:

Direction	Identifier	Format	Message	Data
From Keypad	18EFFF21h	Ext	04 1B 03 01 03 00 10 21	3 Ticks CW with 10h as TOP position
From Keypad	18EFFF21h	Ext	04 1B 03 81 FF FF 00 21	1 Tick CCW

10. Encoder 3 state message (04h)

This message is sent by the keypad to indicate the state of the encoder 3. The destination address is set to FFh: broadcast message.

Note: the encoder 3 is identified with the key number 11. See chapter 2 for further details.

The state of the encoder 1 is represented by 3 counter fields:

- The Direction counter (Byte 3) transmits the number of ticks and the direction of the encoder rotation since the last message sent. The MSB of the counter defines the direction.
- The Tick counter (Byte 4 and 5) is a two bytes counter incremented each clockwise tick and decremented each counterclockwise tick.
- The TOP position (Byte 6): when is different from 00h, it is the maximum value the encoder tick counter will count up to. In this case, with each clockwise tick the counter increases until the TOP position is reached; once reached this value, each further tick in this direction does not increase the counter. On the contrary, with each counterclockwise tick the counter decreases from the current value to zero; once reached zero, each further tick in this direction does not change the counter value.
  NOTE: the default TOP position value can be set by using the configuration command *Set TOP position encoder 3(6Dh)*. In case it is selected the value 00h the maximum encoder tick counter value is 65535.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	04h	Encoder 3 state message
Byte 3	Encoder Direction counter X Y Y Y – Y Y Y Y b	X = 0 clockwise, X = 1 counterclockwise. YYYYYYY = number of Ticks. 1 Turn (360° rotation) = 16 Ticks
Byte 4, 5	ZZ ZZh	Encoder Tick counter
Byte 6	00h or RRh	TOP position encoder 3
Byte 7	ZZh	Keypad Identifier (default 21h)

Examples:

Direction	Identifier	Format	Message	Data
From Keypad	18EFFF21h	Ext	04 1B 04 01 05 00 06 21	5 Ticks CW with 06h as TOP position
From Keypad	18EFFF21h	Ext	04 1B 04 81 FF FF 00 21	1 Tick CCW

11. Encoder 4 state message (05h)

This message is sent by the keypad to indicate the state of the encoder 4. The destination address is set to FFh: broadcast message.

Note: the encoder 4 is identified with the key number 12. See chapter 2 for further details.

The state of the encoder 1 is represented by 3 counter fields:

- The Direction counter (Byte 3) transmits the number of ticks and the direction of the encoder rotation since the last message sent. The MSB of the counter defines the direction.
- The Tick counter (Byte 4 and 5) is a two bytes counter incremented each clockwise tick and decremented each counterclockwise tick.
- The TOP position (Byte 6): when is different from 00h, it is the maximum value the encoder tick counter will count up to. In this case, with each clockwise tick the counter increases until the TOP position is reached; once reached this value, each further tick in this direction does not increase the counter. On the contrary, with each counterclockwise tick the counter decreases from the current value to zero; once reached zero, each further tick in this direction does not change the counter value.
  NOTE: the default TOP position value can be set by using the configuration command *Set TOP position encoder 4(60h)*. In case it is selected the value 00h the maximum encoder tick counter value is 65535.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	05h	Encoder 4 state message
Byte 3	Encoder Direction counter X Y Y Y – Y Y Y Y b	X = 0 clockwise, X = 1 counterclockwise. YYYYYYY = number of Ticks. 1 Turn (360° rotation) = 16 Ticks
Byte 4, 5	ZZ ZZh	Encoder Tick counter
Byte 6	00h or RRh	TOP position encoder 4
Byte 7	ZZh	Keypad Identifier (default 21h)

Examples:

Direction	Identifier	Format	Message	Data
From Keypad	18EFFF21h	Ext	04 1B 05 01 01 00 08 21	1 Tick CW with 08h as TOP position
From Keypad	18EFFF21h	Ext	04 1B 05 81 FF FE 00 21	2 Ticks CCW

12. Analog input message (06h)

This message transmits periodically the analog values with 8-bit resolution of each of the four inputs.

The default transmission period is 80ms, but it is possible to change by the configuration command *Set analog input message period (6Ah)*.

Note: please refer to chapter 1 for the connector pinout.

Note 2: it is possible to connect up to 4 inputs 0-5V. For application examples refer to appendix 2.

Warning: the input voltage range is from 0V to 5V. Do not connect input signals beyond these limits. Damage to the device may occur.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	06h	Analog input message
Byte 3	(Vin·255/5)h 5V=FFh	Input 0
Byte 4		Input 1
Byte 5		Input 2
Byte 6		Input 3
Byte 7	XXh	Keypad Identifier (default 21h)

Examples:

Direction	Identifier	Format	Message	Data
From Keypad	18EFFF21h	Ext	04 1B 06 00 00 99 CC 21	INPUT 0 = 0V INPUT 1 = 0V INPUT 2 = 3V INPUT 3 = 4V
From Keypad	18EFFF21h	Ext	04 1B 06 33 66 00 00 21	INPUT 0 = 1V INPUT 1 = 2V INPUT 2 = 0V INPUT 3 = 0V

13. Digital input message (0Ah)

By this command message, it is possible to read the digital input value.

Note: please refer to chapter 1 for the connector pinout.

Note 2: it is possible to connect up to 4 inputs 0-5V. For application examples please refer to Appendix 2.

Warning: the input voltage range is from 0V to 5V. Do not connect input signals beyond these limits. Damage to the device may occur.

Identifier	18EA2100h	
Byte 0	0Ah	Read digital input 8-bit
Byte 1	00h	Single frame
Byte 2	01h	Enable reading

Answer:

Identifier	18EAFF21h					
Byte 0	0Ah					Command byte
Byte 1	00h					Single frame
Byte 2	XXh					06h: command understood (ACK) 15h: command non accepted
Byte 3	Not used	IN3	IN2	IN1	IN0	‘1’: digital input
	-	08h	04h	02h	01h	
Byte 4,7	00h					Not used

14. Key and Ring encoder LED command (01h)

The following message sent to the keypad allows to switch on/off the Key-LED indicators and the ring LEDs around each of the four encoders.
NOTE: the available colors for the Key-LEDs are shown in the table below.
NOTE 2: the only available ring LEDs color is blue.
NOTE 3: the default Key-LED indicators brightness level can be adjusted by the configuration command 7Ch.
NOTE 4: the default Ring LED indicators brightness level can be adjusted by the configuration command 78h.
See chapter 2 for LED number reference.

Byte 0	04h	Header bytes	
Byte 1	1Bh		
Byte 2	01h	Key-LED command	
Byte 3	XXh	XX: 01h-08h: Key-LED number 1-8	
		09h: Ring LEDs around encoder 1 0Ah: Ring LEDs around encoder 2 0Bh: Ring LEDs around encoder 3 0Ch: Ring LEDs around encoder 4	
Byte 4	YYh	LED Color 00h: on (for ring LEDs only) 01h: red 02h: green 03h: blue 04h: yellow	05h: cyan 06h: magenta 07h: white/light blue 08h: amber/orange 09h: yellow/green
Byte 5	ZZh	LED State 00h: off 01h: on 02h: blink 03h: alternate blink (not available for Ring encoder LED)	
Byte 6	WWh	LED Secondary Color 00h: on (for ring LEDs only) 01h: red 02h: green 03h: blue 04h: yellow	05h: cyan 06h: magenta 07h: white/light blue 08h: amber/orange 09h: yellow/green
Byte 7	FFh	Not used	

Examples:

Direction	Identifier	Format	Message	Data
To Keypad	18EF2100h	Ext	04 1B 01 01 01 01 00 FF	Key-LED #1 red ON
To Keypad	18EF2100h	Ext	04 1B 01 02 02 02 00 FF	Key-LED #2 green blinks
To Keypad	18EF2100h	Ext	04 1B 01 03 00 03 03 FF	Key-LED #3 alt blinks
To Keypad	18EF2100h	Ext	04 1B 01 04 05 03 06 FF	Key-LED #4 blinks cyan and magenta in alternate mode
To Keypad	18EF2100h	Ext	04 1B 01 08 07 01 00 FF	Key-LED #8 white ON
To Keypad	18EF2100h	Ext	04 1B 01 09 00 01 00 FF	Ring LEDs around encoder 1 ON
To Keypad	18EF2100h	Ext	04 1B 01 0A 00 02 00 FF	Ring LEDs around encoder 2 blink

15. Encoder and Central LED command (0Ah)

The following message sent to the keypad allows to switch on/off the encoder and central LED indicators with the state shown in the table below.
NOTE: the default brightness level for this group of LEDs can be adjusted by the configuration command 69h.
See chapter 2 for encoder LED number reference.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	0Ah	Encoder LED command
Byte 3	XXh	XX: 01h-2Ch: LED number 1-44
Byte 4	YYh	LED State 00h: off 01h: on 02h: blink
Byte 5,7	FFh	Not used

Examples:

Direction	Identifier	Format	Message	Data
To Keypad	18EF2100h	Ext	04 1B 0A 01 01 00 00 00	Encoder LED 1 on
To Keypad	18EF2100h	Ext	04 1B 0A 09 02 00 00 00	Encoder LED 9 blinks
To Keypad	18EF2100h	Ext	04 1B 0A 18 01 00 00 00	Encoder LED 24 ON
To Keypad	18EF2100h	Ext	04 1B 0A 20 02 00 00 00	Encoder LED 32 blinks
To Keypad	18EF2100h	Ext	04 1B 0A 27 01 00 00 00	Central LED 39 ON

16. Enable/Disable Encoder state message (0Bh)

This message allows to enable or disable the Encoder state message transmission. Please refer to the chapters 8-9-10-11 for further details.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	0Bh	Set backlight level
Byte 3	XXh	XX: 00h: disabled 01h: enabled
Byte 4,7	FFh	Not used

Example:

Direction	Identifier	Format	Message	Data
To Keypad	18EF2100h	Ext	04 1B 0B 00 FF FF FF FF	Encoder state message transmission disabled

17. Enable/Disable backlight (03h)

This message allows to switch on/off the backlight LEDs around the keys, the encoders and the logo (where applicable).
NOTE: the setting is kept at the startup.
NOTE 2: the default Key-LED backlight brightness level can be adjusted by the configuration command 7Bh.
NOTE 3: the default Key-LED backlight color can be set by the configuration command 7Dh.
NOTE 4: the default Ring backlight brightness level can be adjusted by the configuration command 79h.
NOTE 5: the default Logo backlight brightness level can be adjusted by the configuration command 7Eh.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	03h	Set backlight level
Byte 3	XXh	XX: 00h: OFF 01h: ON
Byte 4,7	FFh	Not used

Example:

Direction	Identifier	Format	Message	Data
To Keypad	18EF2100h	Ext	04 1B 03 01 FF FF FF FF	Backlight enabled

18. Set startup keys message(28h)

This command enables the transmission of the state of the keys during power up.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	28h	Set startup keys message
Byte 3	XXh	XX: 00h Disabled (default) 01h Enabled
Byte 4,7	FFh	Not used

Example:

Direction	Identifier	Format	Message	Data
To Keypad	18EF2100h	Ext	04 1B 28 01 FF FF FF FF	Startup keys message enabled

19. Get software revision (2Ah)

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	2Ah	Get software revision
Byte 3,7	FFh	Not used

Answer:

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	2Ah	Get software revision
Byte 3,6	XXh XXh XXh XXh	SW revision ASCII
Byte 7	00h	Not used

Example

Direction	Identifier	Format	Message	Data
To Keypad	18EF2100h	Ext	04 1B 2A FF FF FF FF FF	Get software revision
From Keypad	18EFFF21h	Ext	04 1B 2A 32 2E 31 34 00	V2.1X

20. Set startup LED show (34h)

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	34h	Set startup LED show
Byte 3	XXh	XX: 00h OFF 01h Complete LED show (default) 02h Fast flash
Byte 4,7	FFh	Not used

Example

Direction	Identifier	Format	Message	Data
To Keypad	18EF2100h	Ext	04 1B 34 00 FF FF FF FF	Set Startup LED show OFF

21. Set startup encoder 1 tick counter value (61h)

The following command allows to set the desired encoder 1 tick counter value at the startup.
NOTE: in case the TOP position has been set, if it is selected a startup counter value higher than the TOP position, the counter starts from the TOP position.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	61h	Startup encoder tick counter value
Byte 3	YYh	Tick counter value LSByte
Byte 4	XXh	Tick counter value MSByte
Byte 5,7	FFh	Not used

Encoder tick counter value: XXYYh (from 0000h to FFFFh: from 0 to 65535)

Examples:

Direction	Identifier	Format	Message	Data
To Keypad	18EF2100h	Ext	04 1B 61 10 00 FF FF FF	Encoder tick counter value set to 16
From Keypad	18EFFF21h	Ext	04 1B 02 01 11 00 00 21	1 Tick CW
From Keypad	18EFFF21h	Ext	04 1B 02 81 0F 00 00 21	1 Tick CCW

22. Set startup encoder 2 tick counter value (62h)

The following command allows to set the desired encoder 1 tick counter value at the startup.
NOTE: in case the TOP position has been set, if it is selected a startup counter value higher than the TOP position, the counter starts from the TOP position.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	62h	Startup encoder tick counter value
Byte 3	YYh	Tick counter value LSByte
Byte 4	XXh	Tick counter value MSByte
Byte 5,7	FFh	Not used

Encoder tick counter value: XXYYh (from 0000h to FFFFh: from 0 to 65535)

Examples:

Direction	Identifier	Format	Message	Data
To Keypad	18EF2100h	Ext	04 1B 62 05 00 FF FF FF	Encoder tick counter value set to 5
From Keypad	18EFFF21h	Ext	04 1B 03 01 06 00 00 21	1 Tick CW
From Keypad	18EFFF21h	Ext	04 1B 03 81 04 00 00 21	1 Tick CCW

23. Set startup encoder 3 tick counter value (63h)

The following command allows to set the desired encoder 3 tick counter value at the startup.
NOTE: in case the TOP position has been set, if it is selected a startup counter value higher than the TOP position, the counter starts from the TOP position.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	63h	Startup encoder tick counter value
Byte 3	YYh	Tick counter value LSByte
Byte 4	XXh	Tick counter value MSByte
Byte 5,7	FFh	Not used

Encoder tick counter value: XXYYh (from 0000h to FFFFh: from 0 to 65535)

Examples:

Direction	Identifier	Format	Message	Data
To Keypad	18EF2100h	Ext	04 1B 63 06 00 FF FF FF	Encoder tick counter value set to 6
From Keypad	18EFFF21h	Ext	04 1B 04 01 05 00 00 21	1 Tick CW
From Keypad	18EFFF21h	Ext	04 1B 04 81 04 00 00 21	1 Tick CCW

24. Set startup encoder 4 tick counter value (64h)

The following command allows to set the desired encoder 4 tick counter value at the startup.
NOTE: in case the TOP position has been set, if it is selected a startup counter value higher than the TOP position, the counter starts from the TOP position.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	64h	Startup encoder tick counter value
Byte 3	YYh	Tick counter value LSByte
Byte 4	XXh	Tick counter value MSByte
Byte 5,7	FFh	Not used

Encoder tick counter value: XXYYh (from 0000h to FFFFh: from 0 to 65535)

Examples:

Direction	Identifier	Format	Message	Data
To Keypad	18EF2100h	Ext	04 1B 64 08 00 FF FF FF	Encoder tick counter value set to 8
From Keypad	18EFFF21h	Ext	04 1B 05 01 07 00 21 FF	1 Tick CW
From Keypad	18EFFF21h	Ext	04 1B 05 81 06 00 21 FF	1 Tick CCW

25. Set analog input message period (6Ah)

This configuration message allows to disable the periodic transmission or change the default transmission period of the analog input message 06h.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	6Ah	Set analog input message period
Byte 3	XXh	XXh: Period in ms ÷ 10 From 08h (80ms) to C8h (2sec) 00h: periodic analog input message disabled
Byte 4,7	FFh	Not used

Example:

Direction	Identifier	Format	Message	Data
To Keypad	18EF2100h	Ext	04 1B 6A 0A FF FF FF FF	Period = 100ms

26. Set TOP position encoder 1 (6Bh)

The following command allows to set the TOP position value for the tick counter of encoder 1.
Note: if the value 00h is selected the maximum tick counter value achievable is 65535.
Note 2: the encoder 1 is identified with the key number 9. See chapter 2 for further details.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	6Bh	Set TOP position encoder 1
Byte 3	XXh	XXh: 00h: Disabled From 02h (02) to 10h (16)
Byte 4,7	FFh	Not used

Example:

Direction	Identifier	Format	Message	Data
To Keypad	18EF2100h	Ext	04 1B 6B 10 FF FF FF FF	TOP position set to 16

27. Set TOP position encoder 2 (6Ch)

The following command allows to set the TOP position value for the tick counter of encoder 2.
Note: if the value 00h is selected the maximum tick counter value achievable is 65535.
Note 2: the encoder 1 is identified with the key number 10. See chapter 2 for further details.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	6Ch	Set TOP position encoder 2
Byte 3	XXh	XXh: 00h: Disabled From 02h (02) to 10h (16)
Byte 4,7	FFh	Not used

Example:

Direction	Identifier	Format	Message	Data
To Keypad	18EF2100h	Ext	04 1B 6C 05 FF FF FF FF	TOP position set to 5

28. Set TOP position encoder 3 (6Dh)

The following command allows to set the TOP position value for the tick counter of encoder 3.
Note: if the value 00h is selected the maximum tick counter value achievable is 65535.
Note 2: the encoder 1 is identified with the key number 11. See chapter 2 for further details.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	6Dh	Set TOP position encoder 3
Byte 3	XXh	XXh: 00h: Disabled From 02h (02) to 10h (16)
Byte 4,7	FFh	Not used

Example:

Direction	Identifier	Format	Message	Data
To Keypad	18EF2100h	Ext	04 1B 6D 02 FF FF FF FF	TOP position set to 2

29. Set TOP position encoder 4 (60h)

The following command allows to set the TOP position value for the tick counter of encoder 4.
Note: if the value 00h is selected the maximum tick counter value achievable is 65535.
Note 2: the encoder 4 is identified with the key number 12. See chapter 2 for further details.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	60h	Set TOP position encoder 4
Byte 3	XXh	XXh: 00h: Disabled From 02h (02) to 10h (16)
Byte 4,7	FFh	Not used

Example:

Direction	Identifier	Format	Message	Data
To Keypad	18EF2100h	Ext	04 1B 60 08 FF FF FF FF	TOP position set to 8

30. Set Destination Address (6Eh)

This message is used to set the addressee node of the Key Contact state transmitted by the keypad.
The default destination address is FFh (broadcast).

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	6Eh	Set Destination Address
Byte 3	XXh	XX: CAN Destination Address From 00h to FFh FEh: reserved
Byte 4,7	FFh	Not used

Example:

Direction	Identifier	Format	Message	Data
To Keypad	18EF2100h	Ext	04 1B 6E 00 FF FF FF FF	CAN destination address set to 00h

31. Baud rate setting (6Fh)

This message is used to change the baud rate of the CAN bus. Connecting only one keypad to the bus when changing the baud rate is recommended. If an invalid value is chosen, then no change is done to the stored value.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	6Fh	Baud rate setting
Byte 3	02h	500kbit/s
	03h	250kbit/s
Byte 4,7	FFh	Not used

Example

Direction	Identifier	Format	Message	Data
To Keypad	18EF2100h	Ext	04 1B 6F 02 FF FF FF FF	Baud rate set to 500kbit/s

32. Set Source Address (70h)

This message is used to change the keypad CAN Source Address and/or the Keypad Identifier. Either or both the Source Address or Keypad Identifier may be changed independently. Connecting only one keypad to the bus when changing the keypad address is recommended. If an invalid value is chosen, then no change is done to the stored value.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	70h	Set Source Address
Byte 3	XXh	XX: CAN Source Address From 01h to FDh FEh: reserved FFh: no change
Byte 4	YYh	YY: Keypad Identifier From 01h to FDh FEh: reserved FFh: no change
Byte 5,7	FFh	Not used

Example:

Direction	Identifier	Format	Message	Data
To Keypad	18EF2100h	Ext	04 1B 70 FA 55 FF FF FF	Source address set to FAh; keypad identifier set to 55h.

33. Periodic key-state transmission (71h)

This message enables or disables the periodic transmission of the Key state.
When enabled, one contact state message is periodically sent for each button of the keypad.
The period is set to 100ms as default value but can be changed by the command 77h.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	71h	Periodic state transmission message
Byte 3	XXh	XX: 00h Disabled (default) 01h Enabled
Byte 4,7	FFh	Not used

Example:

Direction	Identifier	Format	Message	Data
To Keypad	18EF2100h	Ext	04 1B 71 01 FF FF FF FF	Periodic key-state transmission enabled

34. Event state transmission (72h)

This message enables or disables event-driven keys/encoders state messages transmissions. When this feature is enabled, the keypad transmits the state at the time when a key or encoder changes its state.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	72h	Event state transmission
Byte 3	XXh	XX: 00h Disabled 01h Enabled (default)
Byte 4,7	FFh	Not used

Example:

Direction	Identifier	Format	Message	Data
To Keypad	18EF2100h	Ext	04 1B 72 00 FF FF FF FF	Event state transmission disabled

35. LED Acknowledgment (73h)

This command enables or disables the transmission of the LED Acknowledgement message. When this feature is enabled the keypad transmits an acknowledgement message each time a LED Command is received.
Note: the message is available for the Key and Ring LED command only.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	73h	LED Acknowledgement
Byte 3	XXh	XX: 00h Disabled (default) 01h Enabled
Byte 4,7	FFh	Not used

Example:

Direction	Identifier	Format	Message	Data
To Keypad	18EF2100h	Ext	04 1B 73 01 FF FF FF FF	LED acknowledgment enabled
To Keypad	18EF2100h	Ext	04 1B 01 01 04 03 05 FF	Key-LED Command
From Keypad	18EFFF21h	Ext	00 03 01 04 05 FF FF FF	LED Ack message

LED Acknowledgment message:

Byte 0	00h	
Byte 1	XXh	XX: -LED state
Byte 2	YYh	YY: Key number
Byte 3	PPh	PP: Primary color
Byte 4	ZZh	ZZ: Secondary color
Byte 5,7	FFh	Not used

36. Address Claim at boot (74h)

This message enables or disables the address claim procedure.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	74h	Address claim at boot
Byte 3	XXh	XX: 00h Disabled (default) 01h Enabled
Byte 4,7	FFh	Not used

Example:

Direction	Identifier	Format	Message	Data
To Keypad	18EF2100h	Ext	04 1B 74 01 FF FF FF FF	Address claim enabled

Address claiming procedure:

Under normal operation, the keypad application sends an Address Claim parameter group at start up and waits up to 250ms for the other devices connected to the same network to send a message containing the device's address and name. The keypad checks every response and compares the names to see who has the highest priority. If a device is already using the address and has a higher priority, then a new address is selected, and the process starts over. If the keypad has a higher priority than the device in use then it waits for other systems to reply, while the responding device will have to change its address and send an address claim itself. If no message is received after the time (250ms) is up, then the device has claimed the address.

Address claim parameter group:

Priority = 6.
Destination Address should always be the Global Address FFh
Parameter Group Number (PGN) = 60928(EE00h).
Data Length = 8
Data = NAME field

Example:

Direction	Identifier	Format	Message	Data
From Keypad	18EEFF21h	Ext	3F 42 6F 1A 00 82 3C C0	

37. Heartbeat message (75h)

This command enables or disables the transmission of Heartbeat message. This message is designed to indicate to other devices on the bus that this unit continues to function.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	75h	Heartbeat message
Byte 3	XXh	XX: 00h Disabled (default) 01h Enabled
Byte 4	YYh	YY: Period in milliseconds ÷ 10 From 05h (50ms) to FEh (2.54 sec)
Byte 5,7	FFh	Not used

Example:

Direction	Identifier	Format	Message	Data
To Keypad	18EF2100h	Ext	04 1B 75 01 32 FF FF FF	Heartbeat enabled with 500ms period.

Heartbeat generated message:

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	F9h	Heartbeat message
Byte 3	XXh	XX: Message counter, incremented each message sent
Byte 4	K8 K7 K6 K5 K4 K3 K2 K1	Button state indicators Each bit represents a button state 0: OFF 1: ON
Byte 5	0 0 0 0 K12 K11 K10 K9	
Byte 6	FFh	Not used
Byte 7	21h	Keypad identifier

Example:

Direction	Identifier	Format	Message	Data
From Keypad	18EFFF21h	Ext	04 1B F9 F1 10 00 FF 21	Heartbeat message with button 5 pressed.
From Keypad	18EFFF21h	Ext	04 1B F9 F2 00 02 FF 21	Heartbeat message with button 10 pressed

38. Key-state message period (77h)

This message sets the period time for the PERIODIC KEY-STATE TRANSMISSION (71h).

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	77h	Key-state message period
Byte 3	XXh	XX: Period in milliseconds ÷ 10 From 05h (50ms) to FEh (2.54 sec)
Byte 4,7	FFh	Not used

Example:

Direction	Identifier	Format	Message	Data
To Keypad	18EF2100h	Ext	04 1B 77 3C FF FF FF FF	Period set to 600ms

39. Start Demo mode(7Ah)

This message enables the Demo mode function. Demo mode is a special feature that consists in different LED states for each button pressing. Refer to the appendix “Demo mode instructions” to try these special features. Disconnect and reconnect the keypad after sending the message to enter this mode. To exit the Demo mode, send the Disable Demo mode command or another command message.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	7Ah	Start Demo mode
Byte 3	XXh	XX: 00h Disabled (Default) 01h Enabled
Byte 4,7	FFh	Not used

Example:

Direction	Identifier	Format	Message	Data
To Keypad	18EF2100h	Ext	04 1B 7A 01 FF FF FF FF	Demo mode enabled

40. Default Key-LED backlight brightness level (7Bh)

This message sets the default value of the backlight brightness level. The value can be set from 0 to 3Fh (0-100%) of the brightness range.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	7Bh	Default Key-LED backlight brightness level
Byte 3	XXh	XX: Value From 00h (0%) to 3Fh (100%)
Byte 4,7	FFh	Not used

Example:

Direction	Identifier	Format	Message	Data
To Keypad	18EF2100h	Ext	04 1B 7B 10 FF FF FF FF	Default Key-LED backlight level set to 25%

41. Default Key-LED indicators brightness level (7Ch)

This message sets the default value of the Key-LED indicators brightness level. The value can be set from 0 to 3Fh (min-100%) of the LED dimming range.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	7Ch	Default Key-LED indicators brightness level
Byte 3	XXh	XX: Value From 00h (min) to 3Fh (100%)
Byte 4,7	FFh	Not used

Example:

Direction	Identifier	Format	Message	Data
To Keypad	18EF2100h	Ext	04 1B 7C 2F FF FF FF FF	Default Key-LED indicators brightness level set to 75%

42. Default Key-LED backlight color (7Dh)

This message sets the default color of the key-LED backlight.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	7Dh	Default Key-LED backlight color
Byte 3	XXh	XX: color 01: red 02: green 03: blue 04: yellow 05: cyan 06: magenta 07: white/light blue 08: amber/orange 09: yellow/green
Byte 4,7	FFh	Not used

Example:

Direction	Identifier	Format	Message	Data
To Keypad	18EF2100h	Ext	04 1B 7D 07 FF FF FF FF	Default Key-LED backlight color set to blue

43. Default Central and Encoder LED indicators brightness level (69h)

This message sets the default value of the central and encoder LED indicators brightness level. The value can be set from 0 to FFh (min-100%) of the LED dimming range.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	69h	Default central and encoder LED indicators brightness level
Byte 3	XXh	XX: Value From 00h (min) to FFh (100%)
Byte 4,7	FFh	Not used

Example:

Direction	Identifier	Format	Message	Data
To Keypad	18EF2100h	Ext	04 1B 69 00 FF FF FF FF	Default central and encoder LED indicators brightness set to minimum level

44. Default Ring LED indicators brightness level (78h)

This message sets the default value of the ring LED indicators brightness level. The value can be set from 0 to FFh (min-100%) of the LED dimming range.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	78h	Default Ring LED indicators brightness level
Byte 3	XXh	XX: Value From 00h (min) to FFh (100%)
Byte 4,7	FFh	Not used

Example:

Direction	Identifier	Format	Message	Data
To Keypad	18EF2100h	Ext	04 1B 78 FF FF FF FF FF	Default Ring LED indicators brightness level set to 100%

45. Default Ring backlight brightness level (79h)

This message sets the default value of the ring backlight brightness level. The value can be set from 0 to FFh (0-100%) of the LED dimming range.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	78h	Default Ring backlight brightness level
Byte 3	XXh	XX: Value From 00h (0%) to FFh (100%)
Byte 4,7	FFh	Not used

Example:

Direction	Identifier	Format	Message	Data
To Keypad	18EF2100h	Ext	04 1B 79 FF FF FF FF FF	Default Ring LED backlight brightness level set to 100%

46. Default Logo backlight brightness level (7Eh)

This message sets the default value of the logo backlight brightness level. The value can be set from 0 to FFh (0-100%) of the LED dimming range.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	78h	Default Logo backlight brightness level
Byte 3	XXh	XX: Value From 00h (0%) to FFh (100%)
Byte 4,7	FFh	Not used

Example:

Direction	Identifier	Format	Message	Data
To Keypad	18EF2100h	Ext	04 1B 7E 7F FF FF FF FF	Default Logo backlight brightness level set to 50%

47. Set CAN protocol

This set of messages are used to change to the desired CANbus protocol.

- Change from CANopen to J1939:

Direction	Identifier	Format	Message	Data
To Keypad	600h + current CAN ID (default 615h)	Std	2B FF 20 01 01	Change to J1939

- Change from J1939 to CANopen:

Direction	Identifier	Format	Message	Data
To Keypad	18EFXX00h where XXh is the current CAN source address (default 18EF2100h)	Ext	04 1B 80 00 FF FF FF FF	Change to CANopen

APPENDIX: DEMO Mode instructions

In DEMO Mode you can try the following functions by pressing keys on the Racepad.

Entering this mode (opening feature):

- the key-LED indicators are ON with red color;
- the encoder LEDs 1-9-17-25 are ON;
- the ring LED backlight (including logo LEDs if available) is ON

Each time you press the key 1 you can change the key-LED backlight color with the following sequence:

1. Red;
2. Green;
3. Blue;
4. Yellow;
5. Cyan;
6. Magenta;
7. White/light blue;
8. Amber;
9. Yellow/green;
10. OFF.

Holding down the key 2, you can increase the key-LED indicators brightness level.

Holding down the key 3, you can decrease the key-LED indicators brightness level.

Holding down the key 9 (encoder 1), you can increase the ring LED backlight brightness level.

Holding down the key 10 (encoder 2), you can decrease the ring LED backlight brightness level.

If you press the key 4, there are different steps in this sequence:

1. Complete LED show of all colors;
2. Backlight active with keys on in sequence (it is possible to change the Key-LED indicator color by pressing key 1 and the key-LED backlight by pressing key 5);
3. Alternate blinking of Key-LED indicators 1-8 with red color; 2 with amber color; 4 with green color; 6 with white color; 7 with blue color; 5 with cyan color; 3 with yellow color.
4. Return to the opening feature.

If you press the key 8 it is possible to enable/disable the blinking of the ring encoder LEDs.

By rotating the encoders clockwise, you switch the encoders' LEDs ON; counterclockwise you switch the encoders' LEDs OFF.
NOTE: for encoder 4 (identified with key 12) the rotation also enables/disables the central LEDs.

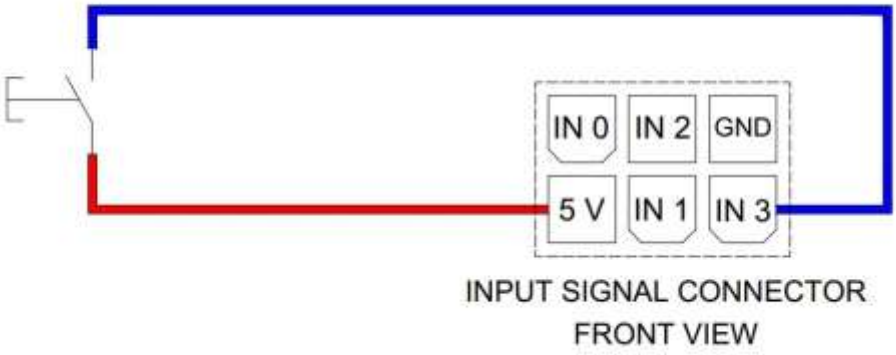
In the case you press the other keys there are no events.

APPENDIX 2: Input application examples

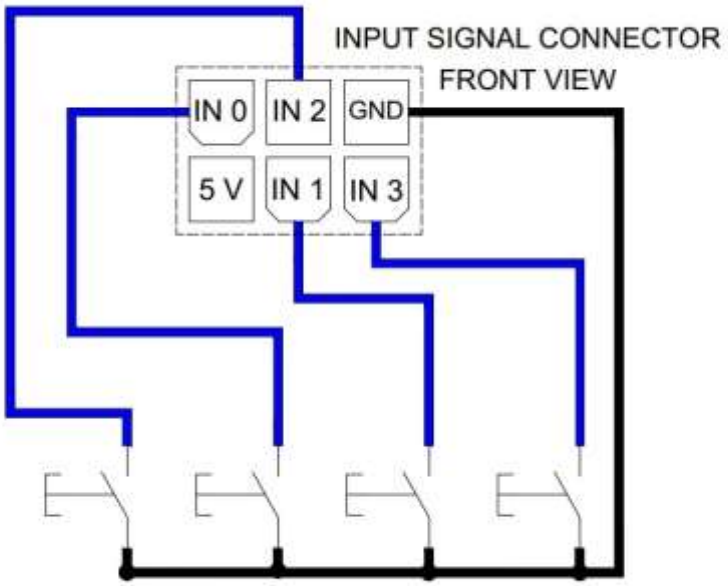
This chapter shows a list of possible input applications.

NOTE: the power supply and ground available on the Input Signal Connector must be used for the external connected devices.

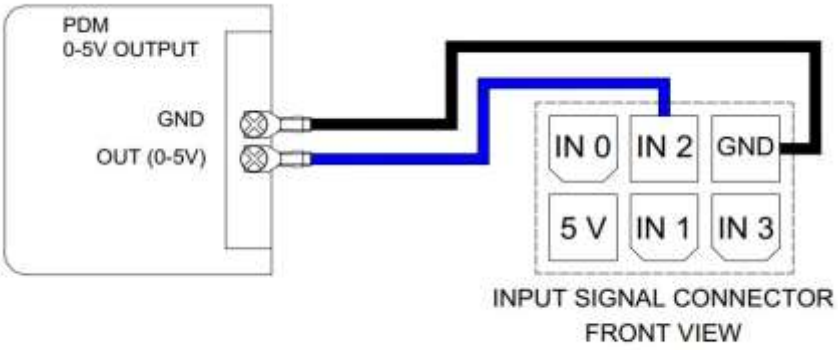
1. Switch high side on input 3:



2. Switch low side on inputs 0, 1, 2, and 3:

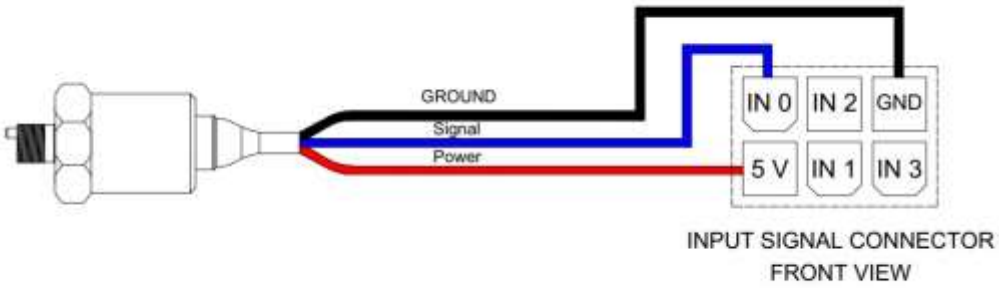


3. Digital active signal on input 2:

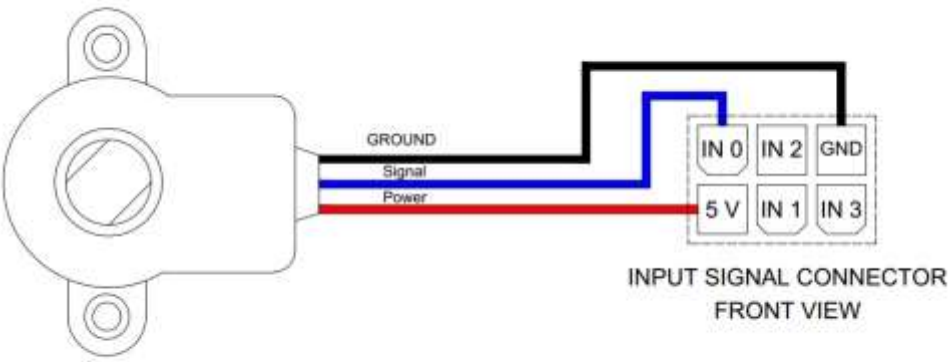


4. Active analog sensor:

- Pressure transducer – signal on input 0



- Hall effect position sensor – signal on input 0



5. The use of passive sensors such as NTC thermistors, potentiometers, and all kind of variable resistors is not recommended!

48. Revision history

Date	Manual Revision	Comment
17/05/2023	1.0	First release